Dissolved and Bubble Gas Concentrations in Sandy Surficial Sediments of the West Florida Sand Sheet

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LONG-TERM GOAL

We hope to further our understanding of biogeochemical and physical processes which control the production, transport and consumption of biogenic gasses in diverse sedimentary environments and sediment types. In these sandy sediments our focus is on oxygen produced through benthic primary production by algae living in the surface sediments.

OBJECTIVES

Through a combination of direct measurements and modeling we wanted to assess the likelihood of a gas phase occurring within the sandy sediments of the proposed sites for the October 1999 experiments of the High Frequency Sound Interaction in Ocean Sediments DRI (Directed Research Initiative). These sites are at approximately 60' water depths off Panama City and Fort Walton Beach, Florida. Since these sediments are sandy and low in organic matter they are very unlikely to produce any methane unless it comes from deeply buried strata. At these water depths, however, there can be significant benthic primary production and thus some potential for generation of oxygen bubbles at the sediment-water interface. We planned to characterize oxygen profiles in the surficial sediments at these sites and determine how they respond to fluxes of photosynthetically active radiation (PAR) which mimic those *in situ*.

APPROACH

Oxygen profiles were to be characterized aboard ship via oxygen microelectrode inserted with a vernier-type micromanipulator. Profiles in a given core were to be followed throughout the day while it incubated on deck under several layers of screening to mimic the light on the bottom. Since we were working at atmospheric pressure, instead of *in*

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situ, we could not suppress the formation of oxygen bubbles at the sediment surface. Bubble formation *in situ* would require much higher concentrations, which would have to build up against very steep diffusive gradients. We will do computer-modeling simulations to determine if bubble formations appears feasible at these sites. We will use an advection-diffusion-reaction model (Martens et al. 1998, Albert et al. 1998) in which we can vary the flux of PAR to the sediment surface, the photosynthetic efficiency and the depth distribution of photosynthesis to see what is required to produce gaseous oxygen under *in situ* pressures. The model output will be dissolved and gaseous oxygen vs. depth profiles for each set of parameters.

WORK COMPLETED

Our participation in the large multi-investigator DRI was to be limited to the site survey period in July 1999. We were aboard the R/V Pelican for two days of sampling between July 17th and July 19th. We took short cores via SCUBA for oxygen profiling at the Panama City and Fort Walton Beach sites. Frequent movement of the ship precluded any datalogging of PAR at the bottom, but several instantaneous measurements were made as a guide for our incubation efforts. We obtained several oxygen profiles while aboard, but ship movements also limited this activity as the vibrations rendered microprofiling impossible. Cores were returned to our home laboratory in Chapel Hill within 24 h of docking and incubation experiments were conducted there. The modeling efforts have not yet begun due to delays caused by changes to our computing facilities.

RESULTS

In the upper 1 m of the water column midday PAR measurements exceeded 1000 $\mu mole \cdot m^{-2} \cdot s^{-1}$, but at the bottom that was reduced by >90% to about 70 $\mu mole \cdot m^{-2} \cdot s^{-1}$. Using 7 layers of screening we were able to keep light levels below this for the incubations (Figure 1).

We found that there was a very active photosynthetic community in these sandy sediments. While collecting the cores it was noted that there was substantially higher organic material in the shallow troughs of the sand ripples than on the crests. Most of this appears to be benthic algal biomass and there were significant differences between cores in their response to light exposure (as measured by oxygen profiles and appearance of oxygen bubbles).

The incubated cores all produced small oxygen bubbles (<1mm diameter) at the surface by mid morning in spite of the fact that the average PAR they were exposed to was probably 1/3 to 1/2 of what they were exposed to *in situ*. Oxygen penetration into the sediment more than tripled during the active photoperiod (Figure 2) from about 1.5 mm in the early morning to >5 mm in late afternoon. Modest supersaturation occurred in the upper millimeter of sediment and in the water just above the sediment. The bubbles that formed adhered to thin filaments that protruded from the sediment 1-2 mm.

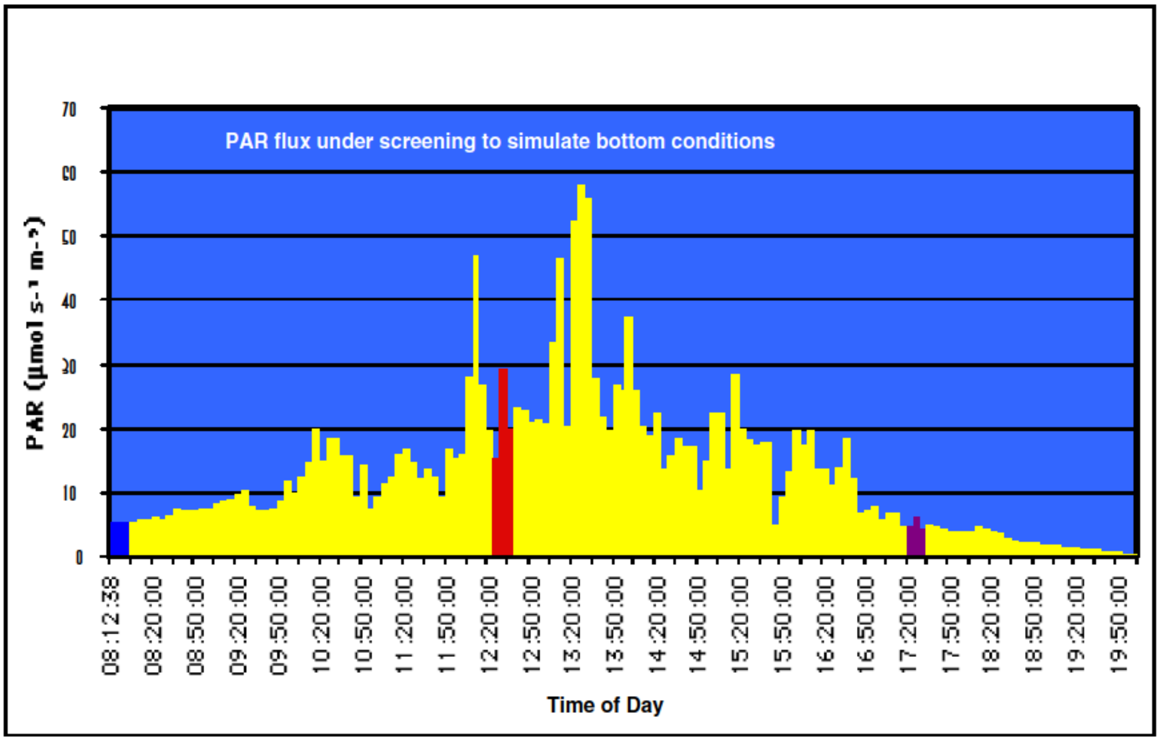

Figure 1. Flux of photosynthetically active radiation to the core in which the oxygen profiles below were measured. Colored bars correspond to approximate times the profiles were measured. The spiky data is characteristic of the use of screening to cut out light.

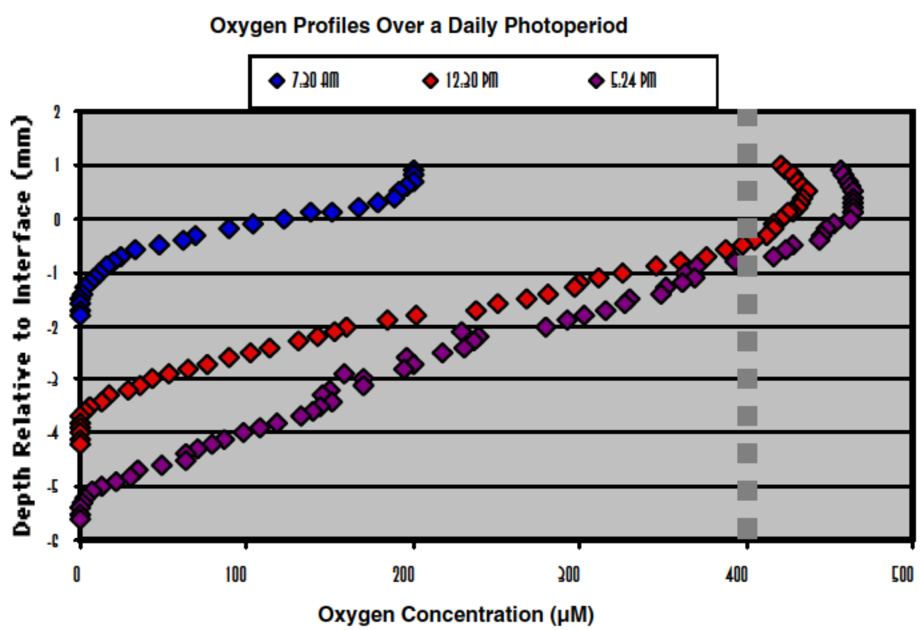

Figure 2. Oxygen profiles in a sandy core from 60' depth off Panama City Beach measured with by microelectrode at various times of day. This core received the light exposure shown in Fig. 1.

IMPACT/APPLICATIONS

The primary impact from this study would have been triggered if we had seen evidence that benthic productivity at these sites was sufficient to cause oxygen supersaturation *in situ*. Site selection for the large field experimental phase of the DRI in October 1999 was based, in part, on the absence of any gas phase in the sediment that could affect the acoustic experiments. Once the modeling is complete it should be possible to place generalized constraints on the occurrence of gaseous oxygen at prospective study sites based on water depth and clarity (due to its effect on PAR supplied to benthic algae).

TRANSITIONS

As stated above, these results helped influence study site selection for the DRI and in the future generalized guidance for site selection (oxygen gas free) should come from the model results.

RELATED PROJECTS

The other projects of the High Frequency Sound Interaction in Ocean Sediments DRI are related in that data interpretation of many of the acoustic experiments is dependent on knowledge of whether or not gas bubbles are present in the sediments.

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